

Acheilognathus majusculus, a New Bitterling (Pisces, Cyprinidae) from Korea, with Revised Key to Species of the Genus *Acheilognathus* of Korea

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Key Words:

Bitterling
Acheilognathus majusculus
Acheilognathus yamatsutae
Cyprinidae

A new bitterling, *Acheilognathus majusculus* is described from 20 specimens collected from the Somjin and Nakdong River, Korea. The new species is similar to *Acheilognathus yamatsutae*, but distinguished from the latter and congeners by the combination of the following characteristics: 15-21 gill rakers, 37-40 vertebrae, longer barbel, greenish body coloration, nuptial color of males and slightly protrusive snout. A key to species of *Acheilognathus* from Korea is included.

The bitterlings of the subfamily Acheilognathinae, which includes six or seven genera and about 40 species (Banareescu, 1990), are small and deep-bodied fishes that inhabit stagnant waters of the East Asia mostly. Although the subfamily Acheilognathinae is well defined, there has been confusion taxonomically at the generic and species levels. Since Berg (1907) described *Acheilognathus signifer* from Korea, subsequent authors (Mori, 1935; Uchida, 1939) reviewed the Korean bitterlings, which included 4 genera and 12 species. Arai and Akai (1988) classified the subfamily Acheilognathine into the three genera of *Rhodeus*, *Acheilognathus* and *Tanakia*, and revived *A. melanogaster* as the type species of *Acheilognathus*. In recent taxonomic studies of the genus *Acheilognathus* in Korea, two species of *Acheilognathus koreensis* and *A. somjinensis* were added by morphometric characters, early developmental stage, and color patterns on body sides (Kim and Kim, 1990, 1991). Although *Acheilognathus yamatsutae* has been for a long time confused taxonomically with *A. cyanostigma* owing to incorrect data from Korea (Mori, 1935; Chyung, 1977; Kim, 1982), morphological variation and taxonomic problems have recently been discussed (Chae and Yang, 1994; Song and Kwon, 1994). In the course of examining these species, the authors found that some characteristics have been overlooked by previous authors and that some populations of the Somjin River and the Nakdong River were previously misidentified as *Acheilognathus yamatsutae*. Therefore, in this paper we describe a new species, *Acheilognathus majusculus*, and compare it with its closest congeners.

Materials and Methods

Counts and measurements are after Hubbs and Lagler (1964). Vertebral counts were from radiography and include four components associated with the Weberian apparatus. Measurements were taken by dial caliper. The specimens were collected by the casting nets and minnow traps from the rivers of southern Korea. The holotype and some paratypes were deposited at the Department of Biology, Chonbuk National University, Chonju, Korea (CNUC). Other paratypes were deposited at the National Science Museum, Tokyo, Japan (NSMT) and the California Academy of San Francisco, USA (CAS).

Systematic Accounts

Family Cyprinidae Cuvier, 1817
Subfamily Acheilognathinae Bleeker, 1863
Genus *Acheilognathus* Bleeker, 1860

Acheilognathus majusculus sp. nov.
(New Korean name: Keunjuinapjaru)
(Fig. 1)

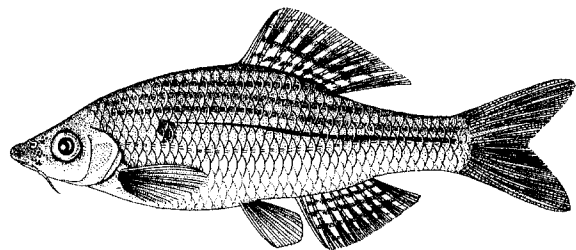


Fig. 1. *Acheilognathus majusculus* sp. nov. holotype (CNUC 21810), 96.4 mm SL, male.

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Table 1. Proportional measurements and meristic counts of *Acheilognathus majusculus* sp. nov. (Mean±SD)

Characters	Holotype		Paratypes	
	Male	Males	Females	Females
No. of individuals	1	9	10	
Standard length (mm)	94.6	53.8-100.4	52.1-83.6	
In standard length (mm)				
head length	24.1	23.2-25.6 (24.5±0.7)	23.6-25.4 (24.4±0.6)	
body depth	35.7	31.2-36.3 (34.0±1.8)	29.0-34.4 (32.0±1.5)	
predorsal length	54.5	51.4-55.7 (54.1±1.4)	52.2-55.8 (53.5±1.1)	
preanal length	65.7	63.6-67.0 (65.4±1.0)	63.5-67.2 (65.0±1.1)	
preventral length	49.2	47.9-49.8 (48.9±0.6)	46.7-50.1 (48.8±1.2)	
prepectoral length	23.4	22.1-24.7 (23.7±0.8)	23.0-25.6 (24.0±0.8)	
caudal peduncle length	20.4	19.0-21.6 (20.1±0.8)	20.0-22.6 (21.2±0.7)	
caudal peduncle depth	12.7	11.8-12.9 (12.4±0.4)	11.4-12.6 (12.0±0.3)	
In head length (mm)				
snout length	35.4	33.3-36.5 (34.8±1.0)	31.1-35.7 (33.6±1.4)	
eye diameter	27.5	23.7-31.6 (28.0±2.5)	27.5-32.5 (29.7±1.5)	
interorbital length	38.5	34.2-40.4 (37.9±2.0)	35.7-40.3 (37.9±1.2)	
barbel length	18.6	11.3-21.1 (16.2±2.9)	12.3-19.0 (15.2±2.5)	
In caudal peduncle length (mm)				
caudal peduncle depth	62.4	54.9-67.7 (62.0±4.1)	52.2-60.3 (56.5±2.1)	
No. of dorsal fin rays	iii 8	iii 8	iii 8 (9)	
No. of anal fin rays	iii 8	iii 8	iii 8	
No. of ventral fin rays	8	8	8	
No. of pectoral fin rays	16	15-16	15-16	
No. of gill rakers	18	17-21 (18.9±1.6)	15-21 (18.0±1.4)	
No. of vertebrae	38	37-39 (37.8±0.6)	37-40 (38.1±0.8)	
No. of lateral line scales	39	37-40 (38.1±0.7)	37-40 (38.1±0.9)	
No. of scale above lateral line	7	6-7 (6.6±0.5)	6-7 (6.5±0.5)	

Holotype: CNUC 21810, 94.6 mm SL (standard length), male, Somjin River, Dae-ri, Kwanchon-myon, Imsil-gun, Chollabuk-do Province, Korea, I. S. Kim and H. Yang, April 18, 1997.

Paratypes: CNUC 23699-23702 (CAS), 69.9-87.3 mm SL, 2 males and 2 females, Nakdong River, Dochon-ri, Sengbiryang-myon, Sanchong-gun, Kyongsangnam-do Province, Korea, H. Yang, August 4, 1997; NSMT-P54556-54559, 58.8-76.5 mm SL, 2 males and 2 females, Nakdong River, Kwangdok-ri, Chinbo-myon, Chongsong-gun, Kyongsangbuk-do Province, Korea, H. Yang and S. H. Choi, Aug. 14, 1997; CNUC 21807, 104.4 mm SL, male, CNUC 21823, 83.6 mm, female, CNUC 21825, 81.8 mm, female, collection data as for holotype; CNUC 23452, 53.8 mm SL, male, CNUC 23458, 71.7 mm SL, male, CNUC 23461, 52.2 mm SL, female, CNUC 23454, 52.1 mm SL, female, Nakdong River, Oksan-ri, Sangdong-myon, Milyang-shi, Kyongsangnam-do Province, Korea, H. Yang, May 2, 1997; CNUC 23633, 67.4 mm SL, male, CNUC 23622, 62.8 mm SL, male, CNUC 23621, 62.2 mm SL, female, CNUC 23620, 64.3 mm SL, female, Nakdong River, Murung-ri, Namhu-myon, Andong-Shi, Kyongsangbuk-do Province, Korea, H. Yang, Aug. 14, 1997.

Diagnosis: *Acheilognathus majusculus* is distinguishable from *A. yamastutae* and its congeners by the following characteristics: 15-21 gill rakers, 37-40 vertebrae; longer barbels; nuptial color of males consisting of greenish background with a dark green stripe from upper rear edge of gill opening to middle of caudal fin base, anal fin with red band submarginally and dark ventral fin without marginal white band.

Description: Proportional measurements and counts for holotype and paratypes are shown in Table 1. Dorsal fin rays iii, 8 (9); Anal fin rays iii, 8; Pectoral fin rays 15-16; Ventral fin rays 8; Anal fin rays iii, 8. First simple ray of dorsal and anal fins very small and hidden under skin. Lateral line scales 37-40. Gill rakers on first arch 15-21. Vertebrae 37-40.

Body compressed and moderately deep. Head short and compressed with snout, slightly protrusive; eye moderately large; maxillary small, reaching to nostrils; horseshoe-shaped mouth inferior and large; a pair of maxillary barbels rather long, slightly more than half diameter of eye, and reaching to middle of eye; nostrils separate and near to eye; interorbital space rather broad and keeled medianly; gill opening large. Scale large, cycloid and some narrowly imbricated on side; lateral line complete and slightly crooked.

Origin of dorsal fin somewhat anterior than origin of ventral and nearer tip of snout than base of caudal; upper edge of dorsal fin convex; origin of anal fin situated under last dorsal ray, its margin slightly convex; caudal fin deeply forked, its lobes pointed.

Largest recorded size 103 mm SL.

Colour: In life body light greenish with a dark green lateral stripe from fifth or sixth scale of lateral line to base of caudal fin; dorsal and caudal fin greyish with a marginal reddish band; anal fin with reddish submarginal and whitish marginal band; ventral fin darker with dense black spots and no marginal white band. In formalin, dark brownish above and light greyish below, a longitudinal blackish stripe from a large black spot at rear of operculum to base of caudal; about 3 or 4 indistinct brownish stripes parallel with above a longitudinal blackish stripe; dorsal and anal greyish with

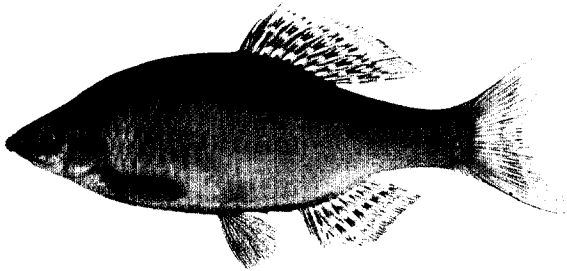


Fig. 2. Nuptial colour pattern in the male of *Acheilognathus majusculus* sp. nov. in breeding season.

several darker longitudinal cross bars and broad marginal whitish band; ventral darker (Fig. 2).

Sexual dimorphism: During breeding season, males have distinct nuptial colour, light greenish body with reddish anal margin as well as reddish, caudal and dorsal margins. Males have dense peal organs on each side of snout and around orbit; females have a pale grey ovipositor reaching to base of caudal fin in breeding season.

Distribution: This species was found in the Somjin River and also in some tributaries (Uiryong, Milyang and Andong) of the Nakdong River, Korea. It was sympatric with *A. yamatsutae* in the Anmang-chon stream (Andong), a tributary of the Nakdong River (Fig. 3).

Ecological notes: *Acheilognathus majusculus* inhabits usually on the bottoms with large stones of fast-flowing streams, more than 1 m deep. The stomachs of adult specimens contained mostly aquatic algae.

Etymology: The name of the new species is derived from the Latin word *majusculus* meaning "somewhat bigger", in reference to bigger body size than the other bitterlings.

Discussion

The bitterling genus *Acheilognathus* is represented by six species in Korea: *Acheilognathus signifer* Berg, *A. lanceolatus* (Temminck et Schlegel), *A. yamatsutae* Mori, *A. rhombeus* Temminck et Schlegel, *A. koreensis* (Kim et Kim), and *A. somjinensis* (Kim et Kim). Of them, *Acheilognathus yamatsutae* has been confused in relation to *A. cyanostigma* of Japan by some investigators (Mori, 1935, 1952; Uchida, 1939; Chyung, 1977; Kim, 1982; Jeon, 1982). Recently it was known that *A. yamatsutae* described by Mori (1928) differed from *A. cyanostigma*, and was divided into two morphotypes or groups based on the barbel length without taxonomic revision (Chae and Yang, 1994;

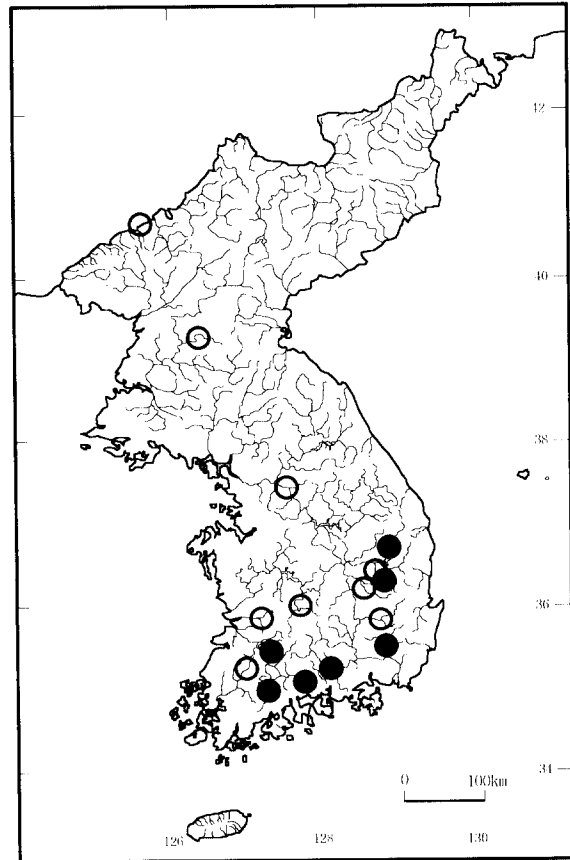


Fig. 3. Map showing the distribution of *A. yamatsutae* (○) and *A. majusculus* sp. nov. (●) in Korea.

Song and Kwon, 1994).

Acheilognathus majusculus sp. nov. closely resembles *A. yamatsutae* in the external morphology and the color patterns on the body. However it differs from *A. yamatsutae* in having 15-21 gill rakers (vs. 8-13), 37-40 vertebrae (vs. 35-37), 37-40 lateral line scales (vs. 35-38), slightly protrusive snout (vs. stumpy snout) in Fig. 4, longer barbels (over half of eye diameter vs. under half of eye diameter), greenish background on body sides and dark ventral fin without marginal white band in the nuptial colour of males (vs. bluish body color and ventral fin with marginal white band) as shown in Table 2 and Fig. 2. *Acheilognathus majusculus* sp. nov. differs from *A. cyanostigma* in having longer barbels (vs. short barbel), slightly round eggs (vs. elongate eggs) and nuptial colour of males (Nakamura, 1969), the occlusal grooves on the pharyngeal teeth, and tubercles on the skin surface in larvae (Suzuki and Jeon, 1987). The new species is also distinguishable from both *A. yamatsutae* and *A. cyanostigma* by larger body size, the largest 100 mm SL (vs. 80 mm SL.) and the habitat with fast rapid waters, depth up to 100 cm and no vegetables (vs. moderate rapid, depth to 30-60 cm and vegetables).

Table 2. Comparison of selective morphometric counts and measurements of *Acheilognathus majusculus* sp. nov. and *A. yamatsutae*.

Characters	<i>A. majusculus</i> sp. nov.		<i>A. yamatsutae</i>		
	Somjin R.	Anmang R.	Anmang R.	Han R.	Kum R.
Standard length (mm)	54.3-100.9	56.2-69.8	53.9-67.8	45.0-67.2	64.7-76.8
Counts					
No. of gill rakers	15-20 (17.7±1.1) ¹	15-21 (18.3±1.3)	11-13 (11.7±0.7)	8-12 (10.2±0.9)	10-12 (10.8±0.6)
No. of vertebrae	37-39 (38.2±0.6)	36-39 (37.6±0.7)	36-37 (36.3±0.5)	35-37 (36.2±0.6)	36-38 (36.9±0.5)
No. of lateral line scales	37-40 (38.6±0.8)	37-39 (37.9±0.6)	36-37 (36.4±0.5)	35-38 (36.4±0.9)	36-38 (36.9±0.6)
No. of scale above lateral line	6-7 (6.6±0.5)	6-7 (6.4±0.5)	5-6 (5.9±0.2)	6-7 (6.1±0.2)	6 (6.0±0.0)
Measurements					
snout length (% of HL)	33.2-40.2 (36.1±1.5)	31.0-35.6 (33.1±1.2)	28.6-34.8 (31.2±1.5)	29.8-33.5 (32.0±1.0)	34.0-39.2 (36.2±1.4)
eye diameter (% of HL)	24.7-30.0 (27.8±1.2)	27.9-33.5 (30.2±1.4)	26.4-32.1 (29.0±1.8)	28.0-31.8 (29.7±0.8)	29.9-31.7 (30.9±0.5)
barbel length (% of HL)	11.6-19.8 (16.9±1.9)	8.9-20.2 (14.5±2.5)	3.8-8.5 (5.9±1.4)	4.2-15.0 (10.9±2.3)	14.4-21.1 (17.6±2.1)
caudal peduncle depth (% of CPL)	51.5-67.7 (58.2±3.8)	52.2-68.2 (58.4±3.4)	42.4-55.9 (49.8±3.7)	50.4-64.1 (57.0±4.1)	54.4-66.2 (58.8±4.3)

¹Mean±SD

HL: head length; CPL: caudal peduncle length

Although *Acheilognathus yamatsutae* was known to be widely distributed in almost all rivers flowing to the west and south coasts of Korea (Uchida, 1939; Chyung, 1977; Kim, 1982), we could not find it in the Somjin River. It is interesting that the new species occurs in the Somjin River and the Nakdong River and exists sympatrically with *A. yamatsutae* in the Anmangchon stream, a tributary of the Nakdong River (Fig. 3). Moreover, it is biogeographically significant that *A. majusculus* sp. nov. is consistently found within the range of *Microphysogobio koreensis* and *Iksookimia longicorpa*, endemic species to Korea.

Key to the species of Acheilognathus from Korea

1. Dorsal fin with 11-13 rays -----*A. rhombeus*
Dorsal fin with 7-10 rays-----2
2. A dark stripe along lateral line with a dark spot on rear of operculum opening-----3
No dark stripe along lateral line and no dark spot on rear of operculum opening-----4
3. Gill rakers with 8-13; bluish body and ventral fin with white band marginally-----*A. yamatsutae*
Gill rakers with 15-21; greenish body and black ventral fin without white band marginally -----*A. majusculus* sp. nov.
4. Brilliant silvery body with narrow brownish stripe on middle caudal peduncle; margin of dorsal fin slightly straight-----*A. lanceolatus*
Dull gray or brownish body without stripe on caudal peduncle -----5

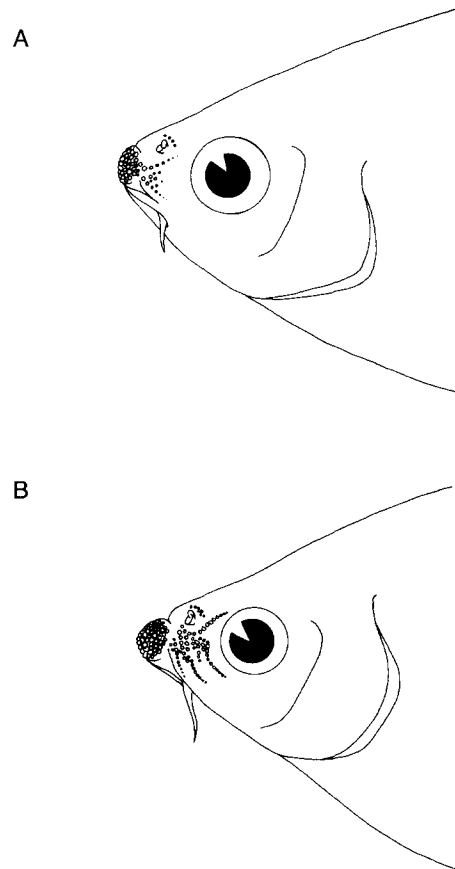


Fig. 4. Comparison of snout shape of *Acheilognathus yamatsutae* (A) and *A. majusculus* sp. nov. (B).

5. Dorsal fin with yellow band submarginally broad, more than eye diameter; lateral line scales 36~37-----*A. signifer*
 Dorsal fin with yellow band submarginally narrow, less than 1/2 eye diameter; lateral line scales 34~35-----6
6. Ovipositer of female during breeding season shorter, not reaching caudal fin base; elongate egg form-----*A. koreensis*
 Ovipositer of female during breeding season longer, exceeding over caudal fin base; egg form elliptical-----*A. somjinensis*

Comparative materials

Acheilognathus yamatsutae: CNUC 22824, 45.0-67.2 mm TL. 5 specimens, South Han River, Hoeyang-ri, Tongsan-myon, Yangpyong-gun, Kyonggi-do Province, Korea, I. S. Kim and C. H. Youn, Aug. 1, 1996; CNUC 23286, 64.7-76.8 mm TL. 10 specimens, Kum River, Naedo-ri, Muju-up, Muju-gun, Chollabuk-do Province, Korea, I. S. Kim, Mar. 2, 1989; CNUC 22729, 47.4-73.9 mm TL. 13 specimens, Mankyong River, Sintak-ri, Pongdong-up, Wanju-gun, Chollabuk-do Province, Korea, H. Yang, Apr. 11, 1997; CNUC 23430, 46.1-62.6 mm TL. 6 specimens, Yongsan River, Taeok-ri, Taejeon-myon, Tamyang-gun, Chollanam-do Province, Korea, H. Yang, Apr. 13, 1997; CNUC 23462, 42.4-64.7 mm, 5 specimens, Nakdong River, Pongjuk-ri, Kumho-up, Yongchon-shi, Kyongsngbuk-do Province, Korea, H. Yang, Apr. 27, 1997; CNUC 23556, 46.1-70.9 mm TL. 20 specimens, Nakdong River, Musong-ri, Kunwi-up, Kunwi-gun, Kyongsangbuk-do Province, Korea, H. Yang, Jun. 18, 1997; CNUC 23640, 53.9-67.8 mm TL, 11 specimens, Nakdong River, Murung-ri, Namhu-myon, Andong-shi, Kyongsangbuk-do Province, Korea, H. Yang, Aug. 14, 1997.

Acheilognathus majusculus sp. nov.: CNUC 24217, 57.8-86.5 mm TL. 15 specimens, Somjin River, Sinyong-ri, Songkwang-myon, Suncheon-shi, Chollanam-do Province, Korea, H. Yang, 13 Jun. 1997; CNUC 24232, 74.5-98.4 mm TL, 7 specimens, Somjin River, Tam-ri, Whagye-myon, Hadong-gun, Chollanam-do Province, Korea, H. Yang, 23 Jun. 1997.

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References

Arai R and Akai Y (1988) *Acheilognathus melanogaster*, a senior synonym of *A. moriokae*, with a revision of the genera of the subfamily Acheilognathinae (Cypriniformes, Cyprinidae). *Bull Natl Sci Mus Tokyo Ser A* 14: 199-213.

Banarescu P (1990) Zoogeography of Fresh Waters. General Distribution and Dispersal of Freshwater Animals. Aula-Verlag, Wiesbaden. Vol 1, pp 1-511.

Berg LS (1907) Description of a new cyprinid fish, *Acheilognathus signifer* from Korea with a synopsis of all the known Rhodeinae. *Ann Mag Nat Hist* 19: 159-163.

Bleeker P (1860) Enumeratio specierum piscium hucusque in Archipelago indico observatarum, adjectis habitationibus citationibus Musei Bleekeriani Bengalensibus, Japonicis, Capensis Tasmanicisque. *Acta Soc Sci Indo-Neerl* 6: 1-276.

Bleeker P (1863) Systema Cyprinoideorum revisum. *Ned Tijdschr Dierk* 1: 187-218.

Chae BS and Yang HJ (1994) Two morphotypes in Korean striped bitterling, *Acheilognathus yamatsutae* Mori (Cyprinidae, Pisces). *Korean J Zool* 37: 49-54.

Chyung MK (1977) The Fishes of Korea. Iljisa Press, Seoul, pp 193-196.

Cuvier G (1817) Le Règne Animal. 2. Fortin, Masson et C. Libraris, Paris, pp 1-532.

Hubbs CL and Lagler KF (1964) Fishes of the Great Lakes region. The University of Michigan Press, Ann Arbor, pp 1-213.

Jeon SR (1982) Studies on the distribution of the Acheilognathid fishes (Cyprinidae) from Korea. *Ann Rept Biol Res Chonbuk Natl Univ Korea* 3: 33-47.

Kim IS (1982) A taxonomic study of acheilognathine fishes (Cyprinidae) in Korea. *Ann Rept Biol Res Chonbuk Natl Univ Korea* 3: 1-18.

Kim IS and Kim CH (1990) A new acheilognathine fish *Acheilognathus koreensis*, (Pisces, Cyprinidae) from Korea. *Korean J Ichthyol* 2: 47-52.

Kim IS and Kim CH (1991) A new acheilognathine fish *Acheilognathus somjinensis* (Pisces, Cyprinidae) from Korea. *Korean J Syst Zool* 7: 189-194.

Mori T (1928) On the freshwater fishes from the Yalu River Korea, with descriptions of new species. *J Chosen Nat Hist Sci* 6: 54-70.

Mori T (1935) Descriptions of three new cyprinoids (Rhodeina) from Chosen. *Zool Mag* 47: 559-574.

Mori T (1952) Check list of the fishes of Korea. *Mem Hyogo Univ Agr* 1: 1-228.

Nakamura M (1969) Cyprinid fishes of Japan. *Spec Publ Res Inst Nat Resou* 4: 23-29.

Song HB and Kwon OK (1994) Geographical variation of *Acheilognathus yamatsutae* from Korea and a morphological comparison with *A. cyanostigma* from Japan. *Korean J Limnol* 27: 127-135.

Suzuki N and Jeon SR (1987) Development of the bitterling, *Acheilognathus yamatsutae* (Cyprinidae), with notes on minute tubercles on the skin surface and pharyngeal apparatus. *Korean J Limnol* 20: 229-241.

Uchida K (1939) The fishes of Tyosen (Korea). Part 1. Nematognathi and Eventognathi. *Bull Fish Exp St Gov Gen Tyosen* 67: 119-133.

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